

OVERVIEW: SCIENTIFIC AND ENGINEERING RESEARCH FACILITIES AT COLLEGES AND UNIVERSITIES: 1998

INTRODUCTION

The availability, condition, and adequacy of the physical facilities needed to conduct science and engineering (S&E) research at our Nation's colleges, universities, and biomedical research institutions have long been a concern of policy makers, higher education administrators, scientists, and engineers. In particular, questions about the following critical issues have been raised:

- How much space is there for conducting S&E research?
- Is this enough space to meet the Nation's S&E research needs?
- What is the condition of this space?
- How much new S&E space needs to be constructed? How much of the existing S&E space needs repair or renovation?
- How much construction and repair/renovation is taking place and what does it cost?
- How do colleges, universities, and biomedical institutions fund these capital projects?
- How has the situation changed over the past decade?

Educators and policy makers have been particularly concerned about the quantity and quality of S&E research space at nondoctorate-granting institutions (those dedicated primarily to undergraduate education), minority-serving institutions (those with relatively large percentages of minority students), and biomedical institutions. These institutions contribute to the scientific enterprise by providing students with the science and engineering education necessary to pursue advanced education and training as well as research and teaching careers in science and engineering.

In the mid-1980s, both the U.S. House of Representatives and the Senate held hearings at which experts testified about the seriousness of the condition of the Nation's S&E research facilities. As a result,

Congress mandated that the National Science Foundation (NSF) collect and analyze data that address a range of S&E research facilities issues. The mandate states:

The National Science Foundation is authorized to design, establish, and maintain a data collection and analysis capability in the Foundation for the purpose of identifying and assessing the research facilities needs of universities and colleges. The needs of universities by major field of science and engineering, for construction and modernization of research laboratories, including fixed equipment and major research equipment, shall be documented. University expenditures for the construction and modernization of research facilities, the sources of funds, and other appropriate data shall be collected and analyzed. The Foundation, in conjunction with other appropriate Federal agencies, shall report the results to Congress. The first report shall be submitted to Congress by September 1, 1986 (42 U.S.C. 1886).

On a biennial basis since 1986, NSF has collected data on S&E research facilities in the Nation's research-performing colleges, universities, and biomedical institutions. This overview presents the major findings from the 1998 survey and provides a summary of changes that have taken place between the 1988 and 1998 surveys. A brief description of the study's methods precedes a discussion of its major findings.

SURVEY METHODS

The 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities was mailed to 465 institutions. In February, 1998, surveys were mailed to 365 academic institutions. In June, 1998, surveys were mailed to 50 nonprofit research organizations and 50 research hospitals. The sample of academic institutions represents 660 colleges and universities that either had research and development (R&D) expenditures

of \$50,000 or more in 1993, or were minority-serving institutions that had any R&D expenditures in that year. The sample of 100 nonprofit research organizations and research hospitals represents the 301 National Institutes of Health (NIH) 1997 grant recipients.

Of the 660 research-performing academic institutions, 57 percent were doctorate-granting and 43 percent were nondoctorate-granting.¹ In Chapters 1 through 8, the doctorate-granting academic institutions are categorized into two groups: “top 100” and “other doctorate-granting” institutions. The top 100 institutions are the 100 academic institutions that had the largest R&D expenditures in 1993 and the other doctorate-granting institutions represent the remaining 278 doctorate-granting academic institutions. In Chapter 9, *Biomedical Research Facilities*, the academic institutions are categorized differently. The 50 academic institutions that had the largest R&D expenditures in 1993 are referred to as the “top 50,” and the remaining 328 academic institutions are referred to as “other-doctorate granting” institutions. In addition, academic institutions that had any research space or capital projects in the biological or medical sciences inside medical schools were identified as “medical schools.”

In 1998, respondents could complete the survey either electronically over the Internet² or on paper. Institutions

that participated in the 1996 survey were sent a computer-generated “facsimile” of their previous responses. Extensive telephone follow-up elicited a high response rate and reduced the number of items that respondents had initially omitted or responded to inconsistently. In all, 304, or 87 percent of all qualified academic institutions, including all of the “top 100,” and 83, or 87 percent of all qualified research hospitals and nonprofit research organizations completed the survey. Of these 387 institutions, 53 percent responded via the Internet and 47 percent completed the paper version of the survey. (See Appendix A, “Technical Notes,” for a detailed description of the sampling procedures and data-collection methods.)

HOW MUCH S&E RESEARCH SPACE DO COLLEGES AND UNIVERSITIES HAVE?

In 1998, the Nation’s colleges and universities had 488 million net assignable square feet (NASF)³ of academic space. Fifty-nine percent of this space, 286 million NASF, was dedicated to instruction and research in science and engineering. Half of this S&E space, 143 million NASF, was devoted specifically to research (table 1).

¹ Throughout this report, these institutions are referred to as ‘research-performing’ institutions. Except where explicitly stated otherwise, the statistics presented in the report are for the weighted values of all institutions represented in the sample.

² In 1996, a Windows-based disk version of the survey was provided as an option.

³ Net assignable square feet is defined as the sum of all areas, in square feet, on all floors of a building assigned to, or available to be assigned to, an occupant for specific use.

Table 1. Amount of space by institution type: 1998

Institution type	Number of institutions	Instructional and research space in all academic fields	Instructional and research space in S&E fields	Research space in S&E fields
NASF in millions				
Total.....	660	488	286	143
Doctorate-granting.....	378	416	261	136
Top 100 in research expenditures.....	100	252	177	101
Other.....	278	164	84	35
Nondoctorate-granting.....	282	72	25	7

KEY: S&E = science and engineering.
NASF = net assignable square feet.

NOTE: Components may not add to totals due to rounding.

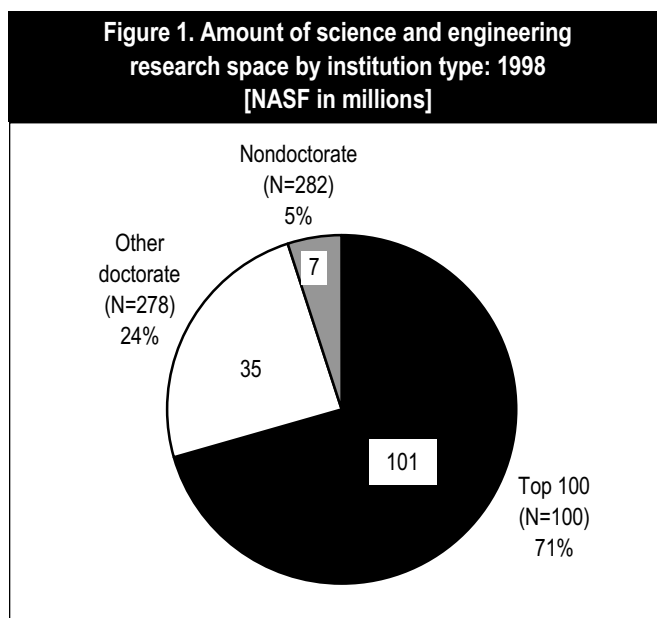
SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

The Nation's S&E research space was distributed across the three types of research-performing institutions as follows (figure 1):

- The top 100 institutions, which represent 15 percent of all research-performing institutions, occupied 71 percent of this space (101 million NASF);
- The other doctorate-granting institutions, which represent 42 percent of all research-performing institutions, occupied 24 percent of this space (35 million NASF); and
- The nondoctorate-granting institutions, which represent 43 percent of all research-performing institutions, occupied 5 percent of this space (7 million NASF).

It should also be noted that while the top 100 institutions represent 15 percent of the total number of research-performing institutions, they accounted for 80 percent of all R&D expenditures⁴ in 1996. Thus, the proportion of S&E research space that they occupy, 71 percent, is roughly proportional to their share of total R&D expenditures.

⁴ The 1998 expenditures data were not available at the time this report was written. The most recent expenditure data, 1996, were therefore used. National Science Foundation, *Academic Research and Development Expenditures: Fiscal Year, 1996*.



KEY: NASF = net assignable square feet.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Almost three quarters (72 percent or 103 million NASF) of the Nation's S&E research space is concentrated in five fields (table 2):

- The agricultural sciences—17 percent or 25 million NASF;
- Engineering—16 percent or 23 million NASF;
- The biological sciences outside medical schools—13 percent or 19 million NASF;
- The physical sciences—13 percent or 18 million NASF; and

Table 2. Existing and needed science and engineering research space by field: 1998

Field	Number of institutions with space*	Existing NASF [In millions]	Percentage of institutions reporting inadequate space	Additional NASF needed [In millions]
Total.....	660	143	83	29
Biological sciences—inside medical schools.....	127	12	70	3
outside medical schools.....	569	19	64	5
Physical sciences.....	556	18	64	4
Psychology.....	474	3	51	1
Social sciences.....	428	5	61	1
Mathematics.....	416	1	44	0
Computer sciences.....	395	2	56	1
Earth, atmospheric, and ocean sciences.....	365	8	62	2
Engineering.....	305	23	60	4
Agricultural sciences.....	108	25	55	2
Medical sciences—outside medical schools.....	280	7	54	2
inside medical schools.....	127	18	67	4
Other sciences.....	149	3	44	1

* Includes only institutions reporting existing and/or needed research space in the specified field.

KEY: NASF = net assignable square feet.

NOTE: Components may not add to totals due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

- The medical sciences in medical schools—13 percent or 18 million NASF.

IS THE AMOUNT OF S&E RESEARCH SPACE ADEQUATE FOR CURRENT RESEARCH COMMITMENTS?

In light of their current research commitments, more than half of all institutions reported inadequate amounts of space in every S&E field except mathematics, where 44 percent of the institutions indicated that the amount of research space was inadequate (table 2). At least 60 percent of all research-performing institutions reported that their research space was inadequate in each of the following seven S&E fields:

- The biological sciences in medical schools—70 percent of institutions reported having inadequate space;⁵
- The medical sciences in medical schools—67 percent of institutions;
- The biological sciences outside medical schools—64 percent of institutions;
- The physical sciences—64 percent of institutions;
- The earth, atmospheric, and ocean sciences—62 percent of institutions;
- The social sciences—61 percent of institutions; and
- Engineering—60 percent of institutions.

To meet their current research commitments, the research-performing institutions reported that they needed an additional 29 million NASF of S&E research space, or 20 percent more than they currently have. Three million or more NASF of research space were needed in each of the following five S&E fields (table 2):

⁵ Reported percentages of institutions include only those that had or needed research space in the field. For example, there were 127 institutions with or needing biological science research space in medical schools (table 2), of which 70 percent (89) reported having inadequate space. By comparison, 569 institutions reported having or needing research space in the biological sciences outside of medical schools. Sixty-four percent of these institutions, or 364, indicated that the amount of space in this field was inadequate.

- The biological sciences outside medical schools (5 million NASF);
- The physical sciences (4 million NASF);
- Engineering (4 million NASF);
- The medical sciences in medical schools (4 million NASF); and
- The biological sciences in medical schools (3 million NASF).

WHAT IS THE CONDITION OF THE NATION'S S&E RESEARCH SPACE?

Over a third (39 percent or 56 million NASF) of S&E research space at research-performing institutions was rated as “suitable for the most scientifically competitive research” (see Chapter 2). However, the research-performing institutions classified 18 percent (26 million NASF) of their research space as needing major renovation and another 5 percent (7 million NASF) as needing replacement. Thus, almost one quarter (23 percent) of all S&E research space requires either major renovation or replacement. Fields with the greatest amount of research space needing major renovation or replacement include:

- The agricultural sciences (7.5 million NASF);
- The biological sciences outside medical schools (4.8 million NASF);
- The medical sciences in medical schools (4.6 million NASF);
- Engineering (4.3 million NASF); and
- The physical sciences (3.9 million NASF).

HOW MUCH CONSTRUCTION AND REPAIR/RENOVATION HAS BEEN DEFERRED?

In 1998, 54 percent of research-performing institutions reported that they had to defer needed S&E construction or repair/renovation projects that would support their current research program commitments because of insufficient funds. The vast majority of institutions that had deferred projects (87 percent) had included at least some of these projects in an approved institutional plan.

The total estimated cost for deferred S&E research construction and repair/renovation projects (both in and not in an institutional plan) was \$11.4 billion in 1998. Deferred construction projects accounted for \$7.0 billion (61 percent) of these costs, while deferred repair/renovation projects accounted for the other \$4.4 billion (39 percent) (see Chapter 6).

Deferred construction costs exceeded \$1 billion in each of three fields. Institutions reported deferred repair/renovation costs in excess of \$500 million in the same three fields. These fields and the deferred costs are:

- The physical sciences: \$1.6 billion in deferred construction and \$901 million in deferred repair/renovation;
- The biological sciences outside medical schools: \$1.2 billion in deferred construction and \$853 million in deferred repair/renovation; and
- Engineering: \$1.0 billion in deferred construction and \$700 million in deferred repair/renovation.

HOW MUCH S&E CONSTRUCTION AND REPAIR/RENOVATION DID INSTITUTIONS START IN 1996 AND 1997?

New construction projects begun in 1996 and 1997 are expected to produce 11.1 million NASF of new S&E research space. This space is the equivalent of about 8 percent of existing research space.⁶ Similarly, new repair/renovation projects begun in 1996 and 1997 are expected to upgrade 15.1 million NASF, about 11 percent of existing research space (see Chapter 3 and Appendix E).

In 1996 and 1997, institutions were less likely to start new construction projects than they were to start repair/renovation projects. Overall, one third of institutions

(30 percent) started new S&E construction projects in 1996 and 1997 and over half (52 percent) started repair/renovation projects (table 3).

Institutions were most likely to start construction projects in the following fields:

- The medical sciences in medical schools—33 percent of institutions;⁷ and
- The agricultural sciences—28 percent of institutions.

Similarly, institutions were most likely to start repair/renovation projects that cost over \$100,000 in the following fields:

- The biological sciences in medical schools—51 percent of institutions;
- The medical sciences in medical schools—41 percent of institutions;
- Engineering—35 percent of institutions; and
- The physical sciences—31 percent of institutions.

HOW MUCH ARE S&E CONSTRUCTION AND REPAIR/RENOVATION PROJECTS EXPECTED TO COST?

New construction projects begun in 1996 and 1997 are expected to cost \$3.1 billion. Projects scheduled to begin in 1998 and 1999 are expected to cost another \$3.9 billion. Institutions reported an additional \$7.0 billion of estimated deferred construction costs. Similarly, new repair/renovation projects costing over \$100,000 begun in 1996 and 1997 are expected to cost \$1.3 billion and projects costing less than \$100,000 are expected to cost \$0.2 billion, for a total of \$1.5 billion in repair/renovation projects in 1996 and 1997. Repair/renovation projects costing more than \$100,000 scheduled to begin in 1998 and 1999 are expected to cost \$1.6 billion. Institutions estimated deferred repair/renovation costs totaling \$4.4 billion (figure 2).

⁶ Because some newly constructed S&E research space replaces existing space, the reader is cautioned against adding NASF under construction to existing NASF to obtain a total NASF once construction is completed. In addition, it should not be assumed that space being constructed is necessarily the same space that institutions report as needed in any given field in 1998.

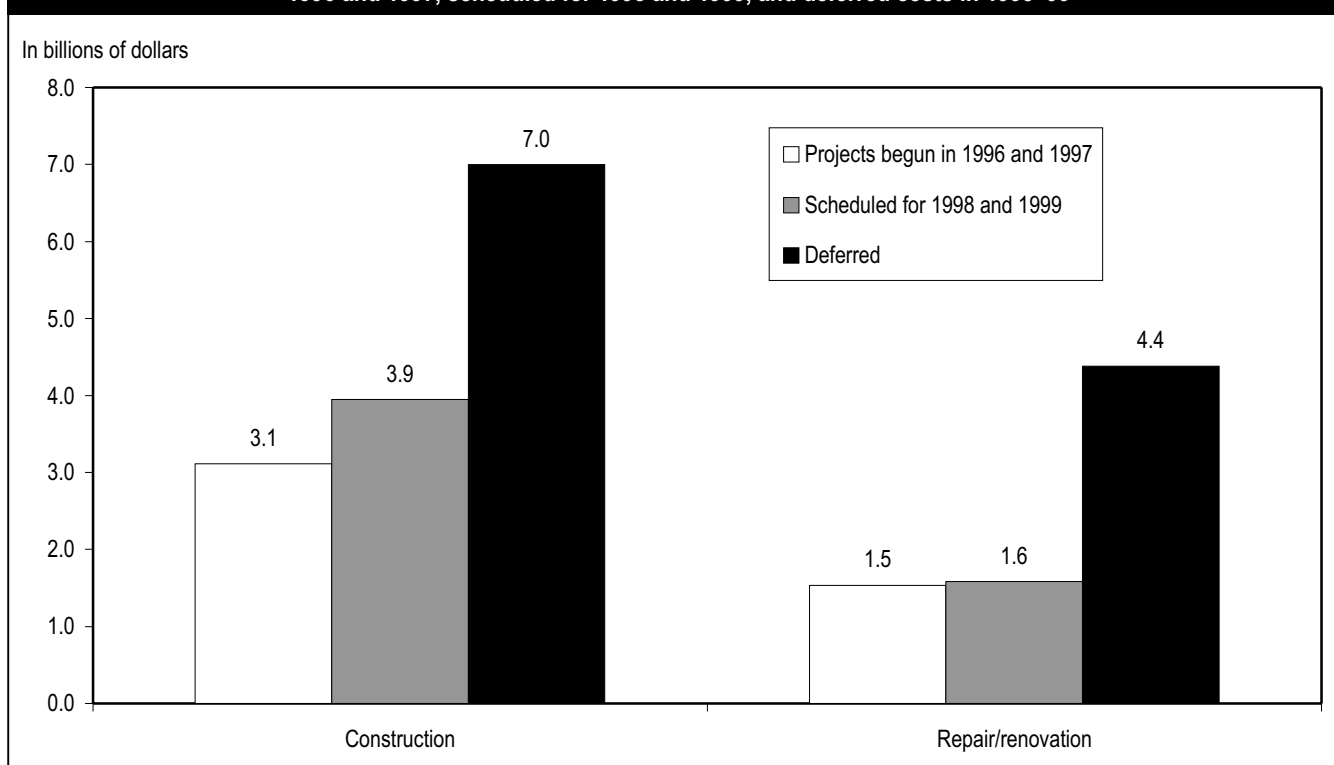
⁷ Percentages are reported only for those institutions that have or plan to construct research space in a given S&E field.

Table 3. Construction and repair/renovation activity by science and engineering field: 1996–97

Field	Percentage of institutions starting new construction	Cost of new construction [In millions of dollars]	Percentage of institutions starting repair/renovation	Cost of repair/renovation [In millions of dollars]
Total.....	30	3,110	52	1,325
Biological sciences—				
inside medical schools.....	14	178	51	164
outside medical schools.....	13	404	29	200
Physical sciences.....	11	381	31	244
Psychology.....	4	77	8	65
Social sciences.....	5	75	12	40
Mathematics.....	1	9	3	5
Computer sciences.....	4	21	5	12
Earth, atmospheric, and ocean sciences.....	11	172	12	52
Engineering.....	11	332	35	208
Agricultural sciences.....	28	273	25	50
Medical sciences—				
inside medical schools.....	33	784	41	196
outside medical schools.....	9	259	25	76
Other sciences.....	10	145	17	11

NOTE: Components may not add due to rounding. Percentages are based on the number of institutions with existing research space or planned construction or repair/renovation of research space in a given field. Only projects costing \$100,000 or more.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Figure 2. Costs of construction and repair/renovation of science and engineering research facilities begun in 1996 and 1997, scheduled for 1998 and 1999, and deferred costs in 1998–99

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Four fields account for more than half (61 percent) of the \$3.1 billion committed to the construction of new research space started in 1996 and 1997 (table 3).

- The medical sciences in medical schools (\$784 million);
- The biological sciences outside medical schools (\$404 million);
- The physical sciences (\$381 million); and
- Engineering (\$332 million).

Five fields account for more than three quarters (76 percent) of the \$1.3 billion committed to the repair/renovation of research space:

- The physical sciences (\$244 million);
- Engineering (\$208 million);
- The biological sciences outside medical schools (\$200 million);
- The medical sciences in medical schools (\$196 million); and
- The biological sciences in medical schools (\$164 million).

HOW ARE COLLEGES AND UNIVERSITIES FUNDING S&E CAPITAL PROJECTS?

Overall, the research-performing institutions derived their S&E capital projects funds from three major sources: the Federal Government, state and local governments, and internal sources. Internal sources consist of private donations, tax-exempt bonds, other debt sources, and other sources (table 4).

Although more than twice as many dollars from each source were allocated to construction project expenses (\$3.1 billion) than to repair/renovation project expenses from projects costing over \$100,000 (\$1.3 billion), the funds were drawn from each source in similar proportions, regardless of the type of project. Internal sources were the largest source of funds for both types of projects:

- Internal sources accounted for 60 percent (\$1,873 million) of all construction funds and 65 percent (\$866 million) of all repair/renovation funds;
- State and local governments accounted for 31 percent (\$967 million) of all construction funds and 26 percent (\$338 million) of all repair/renovation funds; and
- The Federal Government directly accounted for 9 percent of all construction funds (\$271 million) and 9 percent (\$121 million) of all repair/renovation funds. Additionally, some Federal funding comes through overheads on grants and/or contracts from the Federal Government. These overhead payments are used to defray the indirect costs of conducting federally funded research and are counted as institutional funding.

The relative distribution of the three sources of funds for S&E construction and repair/renovation projects differed between the public and private research-performing institutions. The relative distribution of construction funds between institution types is as follows (figure 3):

- Internal sources accounted for 43 percent (\$847 million) of all construction funds at public institutions and 91 percent (\$1,025 million) at private institutions;

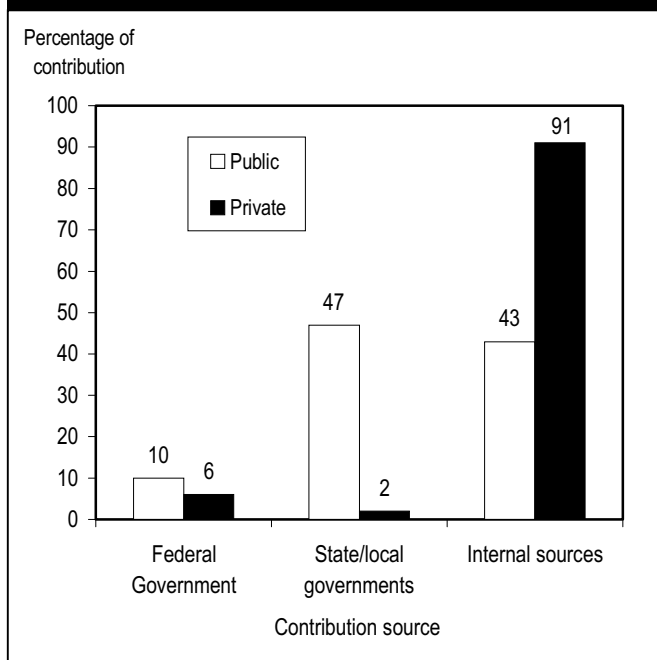
Table 4. Source of funds to construct and repair/renovate science and engineering research space: 1996–97

Source of funds	Percentage of funds for new construction	Percentage of funds for repair/renovation
Total sources.....	100	100
Federal Government.....	9	9
State/local government.....	31	26
Internal sources.....	60	65
Total costs [In billions of dollars].....	3.1	1.3

NOTE: Components may not add to totals due to rounding. Only projects costing \$100,000 or more.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Figure 3. Source of funds for the construction of science and engineering research space by control of institution: 1996–97



NOTE: Components may not add to totals due to rounding.

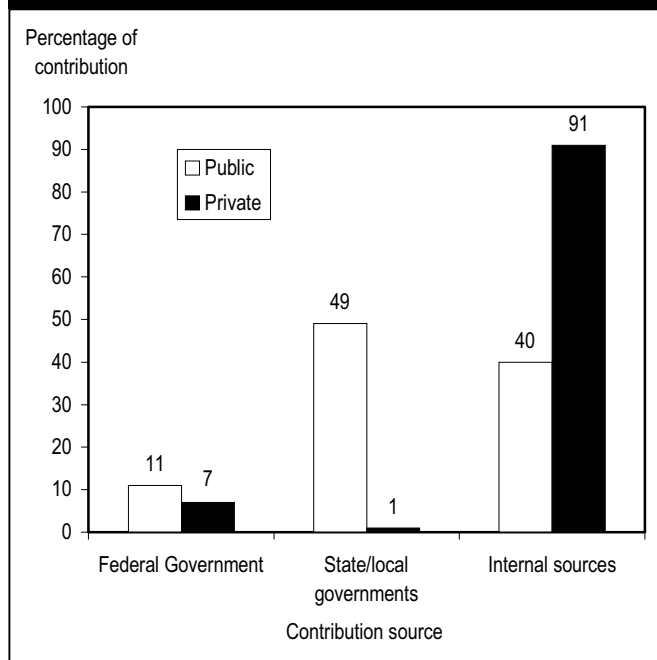
SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

- State and local governments accounted for 47 percent (\$940 million) of all construction funds at public institutions and 2 percent (\$26 million) at private institutions; and
- The Federal Government accounted for 10 percent (\$201 million) of all construction funds at public institutions and 6 percent (\$70 million) of all construction funds at private institutions.

The relative distribution of repair/renovation funds between institution types is as follows (figure 4):

- Internal sources accounted for 40 percent (\$269 million) of all repair/renovation funds at public institutions and 91 percent (\$597 million) at private institutions;
- State and local governments accounted for 49 percent (\$328 million) of all repair/renovation funds at public institutions and 1 percent (\$10 million) at private institutions;
- The Federal Government accounted for 11 percent (\$72 million) of all repair/renovation funds at public institutions and 7 percent (\$48 million) at private institutions.

Figure 4. Source of funds for the repair/renovation of science and engineering research space by control of institution: 1996–97



NOTE: Percentages may not add to 100 due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

WHAT IS THE STATE OF S&E RESEARCH SPACE AT MINORITY-SERVING INSTITUTIONS?

Since its inception, the Survey of Scientific and Engineering Research Facilities at Colleges and Universities has included a subset of Historically Black Colleges and Universities (HBCUs). These institutions have been recognized for their contributions to the education of black students in general and for their role in preparing students for science and engineering careers. NSF has recognized the growth in minority enrollments in higher education overall and, thus, added two other types of minority-serving institutions to the 1998 sample. The inclusion of non-HBCU-Black institutions acknowledges the fact that there are many colleges and universities that enroll large percentages of black students but are not designated as HBCUs. Similarly, as Hispanic enrollments in higher education increase, there is a need to examine institutions serving these students. The group of minority-serving institutions varies in size and focus; it is composed of both nondoctorate and doctorate-granting institutions,

and includes one of the top 100 research-performing institutions. Below is a summary of some of the key characteristics of minority-serving institutions:

- **Number of institutions:** The Nation's 660 research-performing institutions include 57 HBCUs, 13 non-HBCU-Black-serving institutions, and 10 Hispanic-serving institutions. These 80 institutions comprise 12 percent of all research-performing institutions.
- **Amount of S&E research space:** The minority-serving institutions contain 3.9 million NASF of S&E research space, or 3 percent of the total amount of research space across all research-performing institutions.
- **S&E research space by field:** Four fields account for 71 percent of all the S&E research space in minority-serving institutions: engineering, 960 thousand NASF; the agricultural sciences, 710 thousand NASF; the physical sciences, 543 thousand NASF; and the biological sciences outside of medical schools, 519 thousand NASF.
- **Adequacy of amount of space:** At least 60 percent of the minority-serving institutions report inadequate amounts of S&E research space in eight fields: engineering; psychology; the physical sciences; the computer sciences; the biological sciences outside of medical schools; the social sciences; the earth, atmospheric, and ocean sciences; and the medical sciences outside medical schools.
- **Condition of research space:** Seventeen percent of the S&E research space (0.7 million NASF) in minority-serving institutions is reported to require either major renovation or replacement.
- **Construction activity:** Twenty-four percent of the minority-serving institutions started S&E construction projects in either 1996 or 1997. The cost of these projects at the time they were started was \$120 million. The cost of these projects represented 4 percent of the total S&E construction costs undertaken at all research-performing institutions.
- **Repair/renovation activity:** Twenty-nine percent of the minority-serving institutions started S&E repair/renovation projects in either 1996

or 1997. The cost of these projects at the time they were started was approximately \$36 million. The cost of these projects represented 3 percent of the total across all research-performing institutions.

- **Sources of funding:** State and local governments were the primary funding source for both construction and repair/renovation projects over \$100,000 in minority-serving institutions, followed by internal sources (table 5).

HOW MUCH ANIMAL RESEARCH SPACE DO THE NATION'S COLLEGES AND UNIVERSITIES HAVE?

The 83 percent of research-performing institutions that have animal laboratory facilities reported a total of 11.9 million NASF of animal research space. This represents 8 percent of all S&E research space.

The distribution of animal research space across types of institutions parallels the distribution of all S&E research space. In addition, the proportion of animal research space as a part of all S&E research space is roughly 8 percent at each type of institution:

- The top 100 institutions occupy 71 percent (101 million NASF) of all S&E research space and have 72 percent (8.5 million NASF) of all animal research space;

Table 5. Source of funds to construct and repair/renovate science and engineering research space at minority-serving institutions: 1996-97

Source of funds	Percentage of funds for new construction	Percentage of funds for repair/renovation
Total sources.....	100	100
Federal Government.....	21	17
State/local governments.....	42	63
Internal sources.....	37	20
Total costs [In millions of dollars].....	120	36

NOTE: Components may not add to totals due to rounding. Only projects costing \$100,000 or more.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

- The other doctorate-granting institutions occupy 24 percent (35 million NASF) of all S&E research space and have 23 percent (2.7 million NASF) of all animal research space; and
- The nondoctorate-granting institutions occupy 5 percent (7 million NASF) of all S&E research space and have 5 percent (0.6 million NASF) of all animal research space.

WHAT IS THE STATE OF THE NATION'S BIOMEDICAL RESEARCH FACILITIES?

Biomedical research facilities are a critical component of the Nation's science and engineering research system. This report assesses the amount, quality, and condition of biomedical research space at the Nation's biomedical research-performing institutions. Below is a summary of some of the key characteristics of these institutions.

The Nation has 908 biomedical research-performing institutions. These include 612 academic institutions (colleges, universities, and medical schools), 171 nonprofit research organizations, and 125 research hospitals.

The biomedical research-performing institutions had 73.3 million NASF of biomedical research space in 1998. Slightly more than half of this space (53 percent or 38.9 million NASF) was in the biological sciences; the other 47 percent or 34.4 million NASF was in the medical sciences. More than three quarters of the biomedical research space (77 percent or 56.2 million NASF) was located in academic institutions. Nonprofit research organization accounted for 13 percent (9.5 million NASF) of all biomedical research space, while research hospitals accounted for 10 percent (7.6 million NASF). The HBCUs had 1.2 percent (670 thousand NASF) of all the biomedical research space in the Nation's biomedical research-performing institutions: 73 percent of this space (490 thousand NASF) was in the biological sciences; 28 percent (190 thousand NASF) was in the medical sciences.

Overall, 65 percent of institutions with existing or needed research space in the biological sciences and 52 percent of institutions with existing or needed research space in the medical sciences reported that the amount

of biomedical research space they had was inadequate to meet their research commitments. Similarly, 71 percent of the HBCUs with existing or needed research space in the biomedical sciences reported that the amount of space they had was inadequate to meet their current biomedical research commitments.

In order to meet their current research commitments, the biomedical institutions reported that they needed an additional 9.0 million NASF of research space in the biological sciences or 23 percent more than they currently have. At the same time, they reported that they needed an additional 7.1 million NASF of research space in the medical sciences or 21 percent more than they currently have.

In fiscal years 1996 and 1997, 172 biomedical research-performing institutions started construction on 7.4 million NASF of research space: 116 institutions started construction on 3.5 million NASF of research space in the biological sciences; 81 institutions started construction on 3.9 million NASF of research space in the medical sciences.

In fiscal years 1996 and 1997, 379 biomedical research institutions started repair/renovation projects on 9.0 million NASF of biomedical research space: 282 institutions began repair/renovation projects on 5.5 million NASF of research space in the biological sciences; 172 institutions began repair/renovation projects on 3.5 million NASF of research space in the medical sciences. The biomedical research-performing institutions reported \$5.6 billion in construction and repair/renovation projects that had to be deferred because of insufficient funds. Construction projects account for 64 percent (\$3.6 billion) of the total deferred capital project costs.

In 1998, 700 of the 908 biomedical research-performing institutions (77 percent) had animal laboratory facilities. These institutions reported a total of 14 million NASF of animal research space. Most of this space (83 percent or 12 million NASF) was located in academic institutions.

LOOKING BACK OVER THE DECADE

The 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities provides an opportunity to examine the status of the Nation's S&E

research facilities over a ten-year period.⁸ While some aspects of facilities (e.g., the amount of space) have changed gradually and steadily over the decade, other aspects (e.g., construction and repair/renovation starts) have tended to fluctuate over this period.⁹

AMOUNT OF RESEARCH SPACE

The amount of S&E research space in the Nation's research-performing colleges and universities has grown

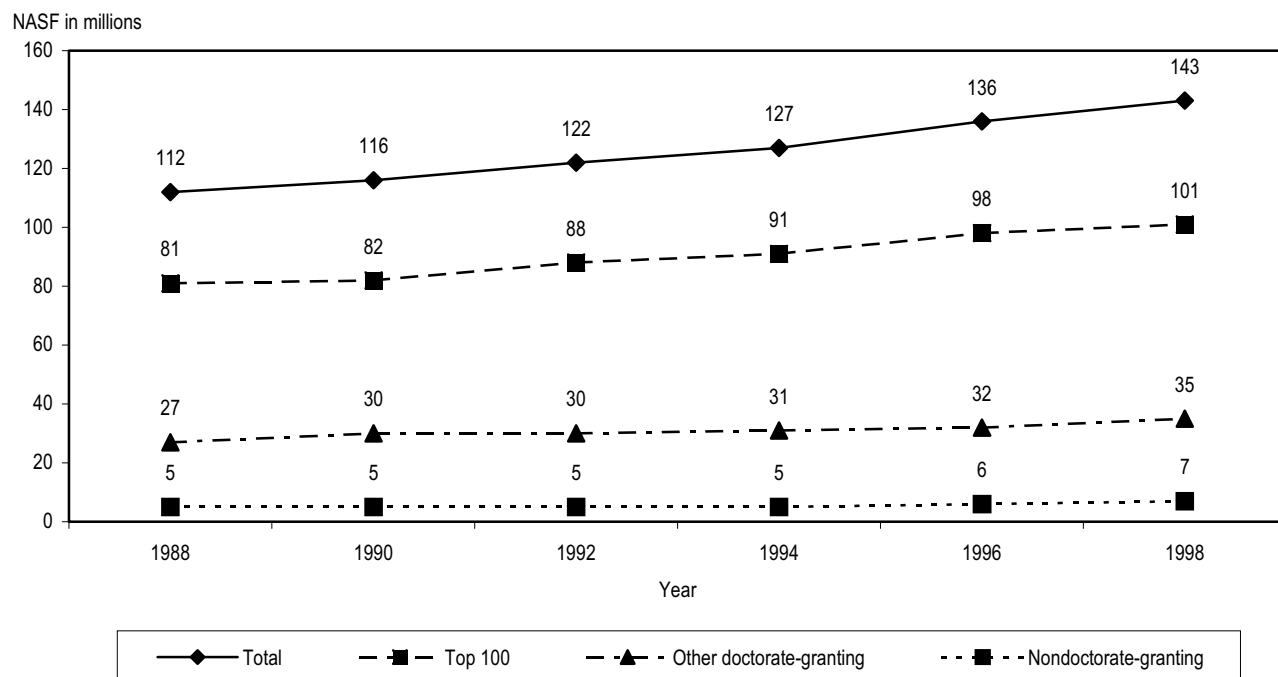
⁸ While the Survey of Scientific and Engineering Research Facilities at Colleges and Universities has collected data on a number of the same issues over time, modifications to individual questions have occurred and new questions that address issues that arose between survey periods have been added. It should also be noted that the institutions sampled change over time, particularly for the other doctorate-granting and nondoctorate-granting groups. In addition, the classification of some institutions changed, e.g., institutions that did not grant doctorate degrees in one period did so at a later period. The sampling frame, however, has always reflected those institutions with R&D expenditures of \$50,000 or more and, starting in 1992, Historically Black Colleges and Universities with any R&D expenditure.

⁹ We limit our discussion to changes over time where the 1986–87 estimate falls outside the 1996–97 estimate's 95 percent confidence interval.

continuously over the decade. In 1988, there were 112 million NASF of research space. Ten years later, there were 143 million NASF, a 28-percent increase. Doctorate-granting institutions account for most of the growth in actual S&E research space over this period (figure 5):

- At the top 100 institutions, S&E research space increased by 25 percent or 20 million NASF (from 81 million NASF to 101 million NASF);
- At other doctorate-granting institutions, S&E research space increased by 30 percent or 8 million NASF (from 27 million NASF to 35 million NASF); and
- At nondoctorate-granting institutions, S&E research space increased by 40 percent or 2 million NASF (from 5 million NASF to 7 million NASF).

Figure 5. Trends in the amount of science and engineering research space by institution type: 1988–98



KEY: NASF = net assignable square feet.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities; and *Scientific and Engineering Research Facilities at Colleges and Universities: 1996*, table 1-3, p 1-6.

Increases in the amount of S&E research space in the individual S&E fields were gradual and fairly even across fields.

THE CONDITION OF S&E RESEARCH SPACE

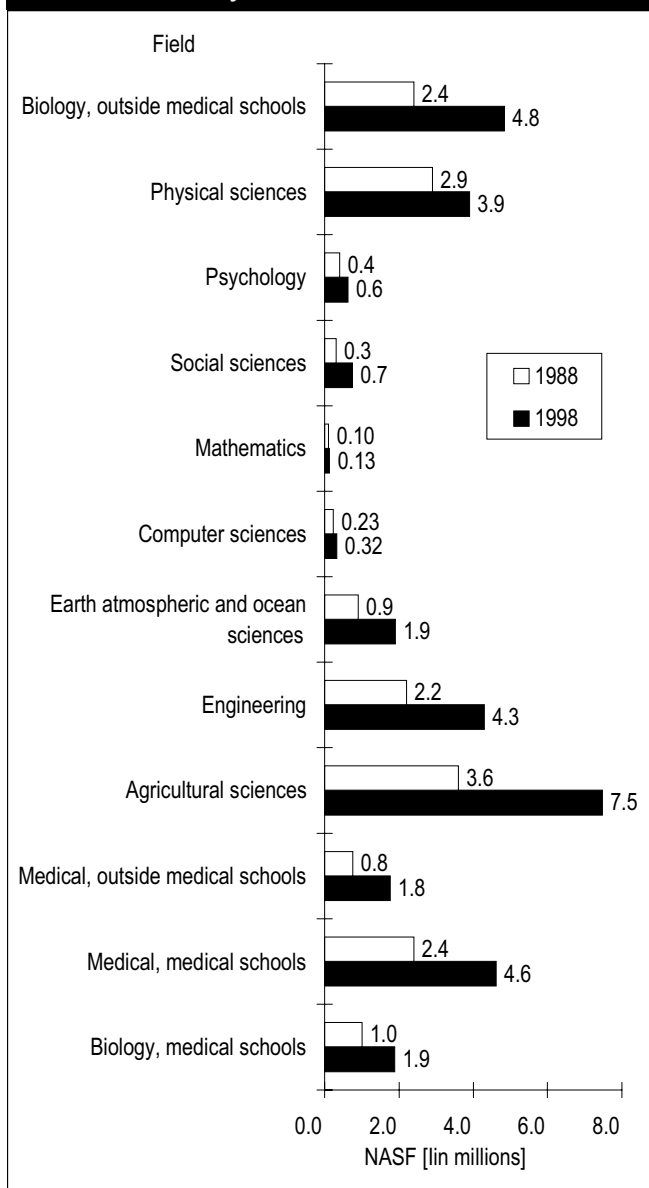
In 1988, 24 percent of all research space was rated as “suitable for the most scientifically competitive research,” whereas in 1998, 39 percent of all of research space was rated as being in this highest quality condition (see Appendix E). The amount of research space reported to need major renovation or replacement to meet current research commitments also has increased continuously, from 16 to 23 percent, over the past ten years. In 1988, 17.7 million NASF of all S&E research space required repair or renovation compared with 33.0 million NASF in 1998.

In this ten-year period, the amount of research space requiring renovation or replacement has increased in every S&E field. In eight out of the twelve fields, the amount of research space in this condition has nearly doubled over the decade (figure 6):¹⁰

- The social sciences research space in need of renovation or replacement increased from 0.3 million NASF to 0.7 million NASF;
- The medical sciences outside medical schools: from 0.8 million NASF to 1.8 million NASF;
- The earth, atmospheric, and ocean sciences: from 0.9 million NASF to 1.9 million NASF;
- The agricultural sciences: from 3.6 million NASF to 7.5 million NASF;
- The biological sciences outside medical schools: from 2.4 million NASF to 4.8 million NASF;
- The biological sciences in medical schools: from 1.0 million NASF to 1.9 million NASF;
- The medical sciences in medical schools: from 2.4 million NASF to 4.6 million NASF; and
- Engineering: from 2.2 million NASF to 4.3 million NASF.

¹⁰ Due to differences in the standard errors of each estimate, changes over time of the same magnitude may not have the same interpretation.

Figure 6. Amount of science and engineering research space needing major renovation or replacement by field: 1988 and 1998



KEY: NASF = net assignable square feet.

SOURCE: National Science Foundation/Division of Science Resources Studies (SRS), 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities; and *Scientific and Engineering Research Facilities at Colleges and Universities: 1996*, table 2-3, p 2-6.

NEW CONSTRUCTION AND REPAIR/RENOVATION PROJECTS

The amount of new research space under construction and the amount of research space affected by repair/renovation projects have fluctuated over time. In 1996 and 1997, research-performing institutions began construction on 11.1 million NASF; in 1986 and 1987, con-

struction was begun on 9.9 million NASF. The amount of S&E research space affected by new repair/renovation projects in 1996 and 1997 was 15.1 million NASF; the amount of research space repaired or renovated in 1986 and 1987 was 13.4 million NASF (see Appendix E).

Overall, the proportion of institutions (30 percent) starting construction projects in 1996 and 1997 is less than the proportion (37 percent) that started construction projects ten years earlier, in 1986 and 1987. The proportion of institutions beginning new construction projects in two fields changed over the decade:

- Engineering decreased from 28 percent of institutions to 11 percent; and
- The agricultural sciences decreased from 38 percent of institutions to 28 percent.

The proportion of institutions (52 percent) starting new repair/renovation projects in 1996 and 1997 was similar to the proportion (56 percent) that started repair/renovation projects in 1986 and 1987. However, a change in the proportion of institutions beginning new repair/renovation projects over the decade occurred in four fields:

- The physical sciences increased from 22 percent of institutions to 31 percent;
- Engineering decreased from 42 percent of institutions to 35 percent;
- The medical sciences outside medical schools increased from 12 percent of institutions to 25 percent; and
- The medical sciences in medical schools decreased from 54 percent of institutions to 41 percent.

THE COST OF CONSTRUCTION AND REPAIR/RENOVATION PROJECTS

The total costs of new construction and repair/renovation projects have fluctuated over time. However, in 1996 and 1997, research-performing institutions committed 15 percent more funds (in inflation-adjusted dollars) for capital projects costing over \$100,000 than they did a decade ago. In 1986 and 1987, they committed \$2.7 billion to new construction projects compared with

\$3.1 billion in 1996 and 1997; and \$1.1 billion to repair/renovation compared with \$1.3 billion in 1996 and 1997¹¹ (figure 7).

Although the amount of funds committed to new construction projects costing over \$100,000 has varied over time by field, construction expenditures approximately doubled or more in three fields since 1986–87:

- In mathematics, the amount of funds increased \$7 million, from \$2 million to \$9 million;
- In the earth, atmospheric, and ocean sciences, the amount of funds increased \$97 million, from \$75 million to \$172 million; and
- In the medical sciences in medical schools, the amount of funds for new construction projects increased \$385 million, from \$399 million to \$784 million.

The amount of funds committed to repair/renovation projects costing over \$100,000 has also varied over time by field. The repair/renovation expenditures increased in four fields:

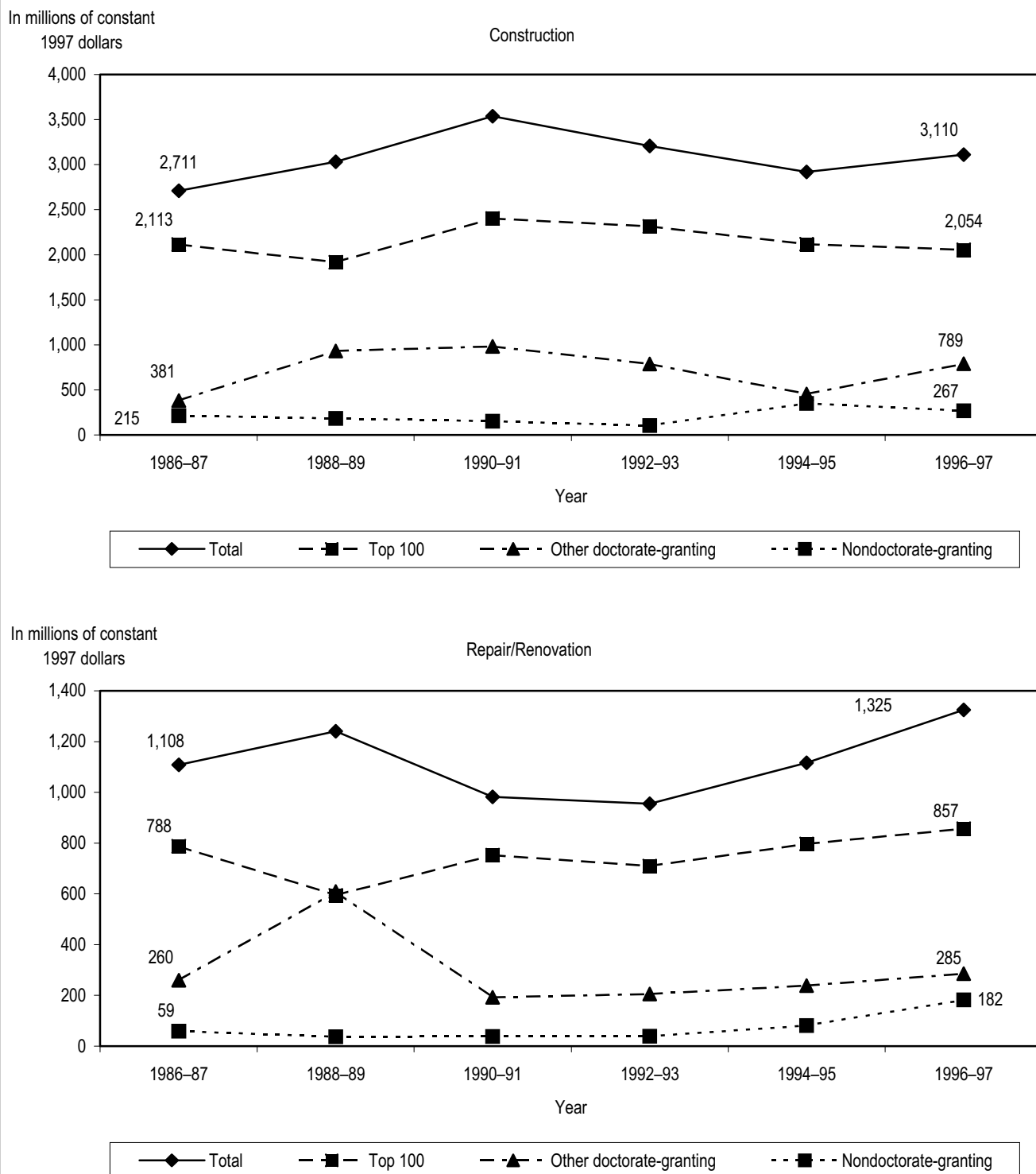
- In psychology, the amount of funds committed to repair/renovation projects increased \$47 million, from \$18 million to \$65 million;
- In the earth, atmospheric, and ocean sciences, the amount of funds increased \$25 million, from \$27 million to \$52 million;
- In the physical sciences, the amount of funds increased \$105 million, from \$139 million to \$244 million; and
- In the biological sciences in medical schools, the amount of funds increased \$62 million, from \$102 million to \$164 million.

SOURCES OF FUNDS

The first survey period for which data are presented in this report on the different sources of funds committed to new construction and repair/renovation

¹¹ All dollar figures are adjusted to 1997 levels using the U.S. Bureau of the Census' Composite Fixed Price Index for Construction.

Figure 7. Trends in expenditures on science and engineering research space construction and repair/renovation starts by institution type: 1986-97



NOTE: All dollar figures are adjusted to 1997 levels using the U.S. Bureau of the Census' Composite Fixed Price Index for Construction.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities; and *Scientific and Engineering Research Facilities at Colleges and Universities: 1996*, table 3-2, p 3-5.

projects is 1990 and 1991. In 1990 and 1991, institutions provided 55 percent (\$2.47 billion) of the \$4.52 billion committed to the construction and repair/renovation of S&E research facilities costing over \$100,000. State and local governments provided 32 percent (\$1.43 billion) of the total combined funds, and the Federal Government provided 14 percent (\$0.61 billion).

In 1996 and 1997, institutions provided 62 percent (\$2.74 billion) of the \$4.4 billion committed to the construction and repair/renovation of S&E research facilities costing over \$100,000 (\$4.44 billion). State and local governments provided 29 percent (\$1.31 billion) and the Federal Government provided 9 percent (\$0.39 billion).